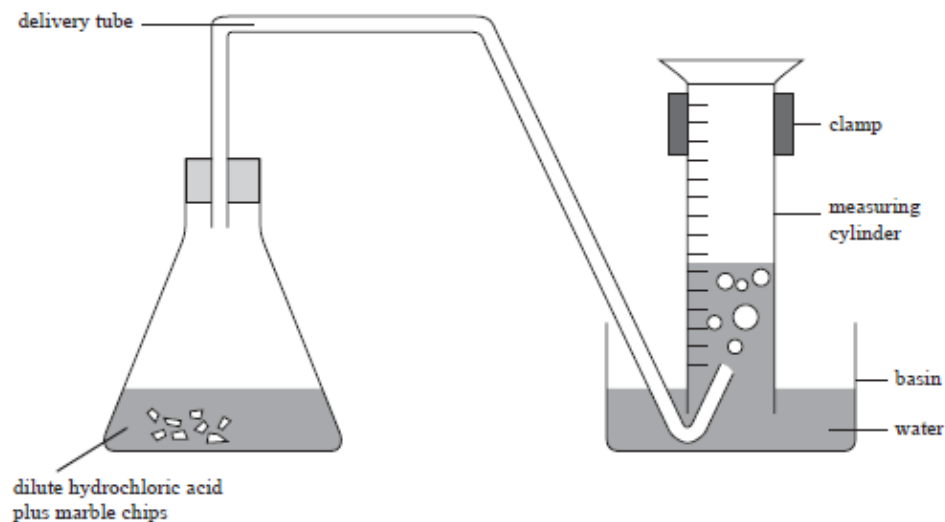


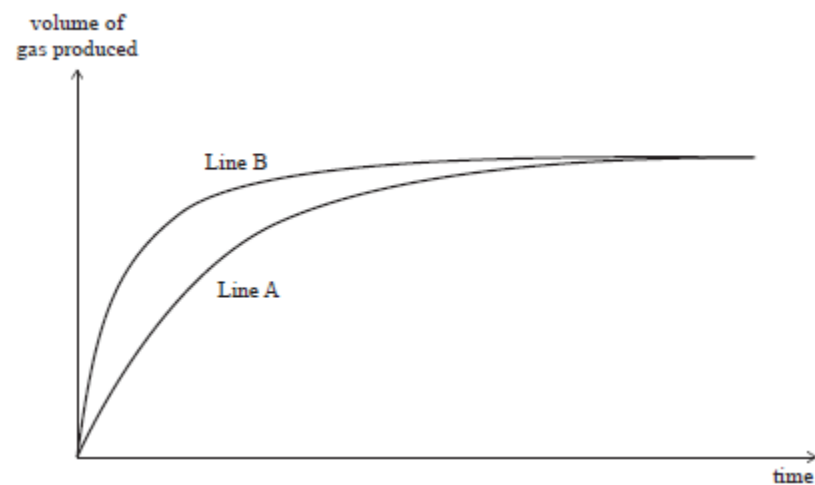
Rate of Reaction

1) The following experiment was carried out at 20°C and then repeated at 40°C.

Marble chips (calcium carbonate) were added to hydrochloric acid in a conical flask. The mass and size of marble chips, and the concentration and volume of hydrochloric acid used, were the same for both experiments. The flask was connected to an inverted measuring cylinder in a basin of water, as shown in the diagram below.



The volume of gas produced at the two different temperatures was measured for a few minutes and the results were used to sketch the graph shown below.



State which line on the graph represents the reaction at 40°C and explain how you worked this out.

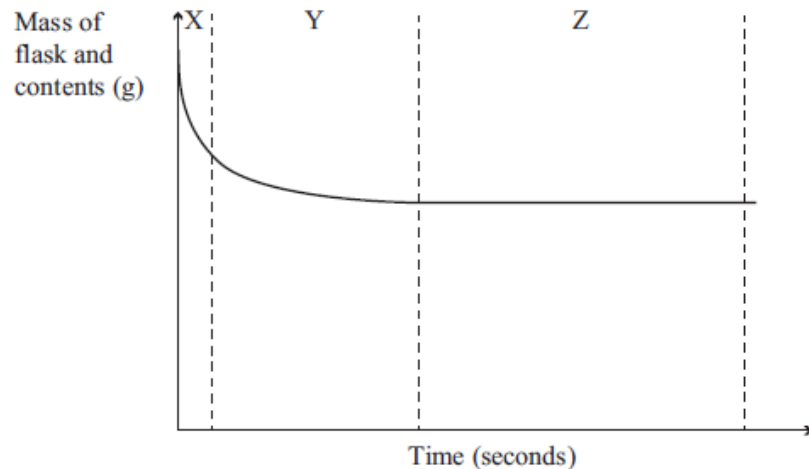
In your answer you should:

- identify which line represents the reaction at 40°C
- explain why the line you have identified is the reaction at 40°C
- give reasons for the different rates of reaction in terms of particles
- explain why both lines end up horizontal.

2) Calcium carbonate (marble chips) and hydrochloric acid react together in a conical flask. The word equation for this reaction is:

calcium carbonate + hydrochloric acid \rightarrow calcium chloride + water + carbon dioxide gas

(a) Describe an observation you would make when this reaction occurs. The mass of the flask and contents is measured on a scale over time and recorded on the graph shown below.



(b) Explain why the mass decreases with time. In your answer you should:

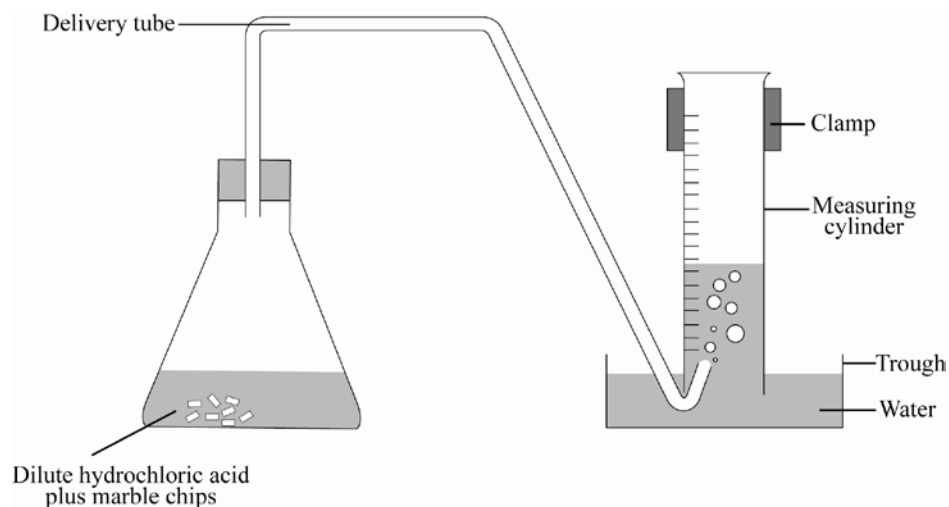
- consider all the products being formed
- explain what is happening, in terms of particles AND the rate of reaction, in each section of the graph.

(c) When more concentrated hydrochloric acid is used, the reaction is faster.

Explain the difference in the rate of reaction. In your answer you should refer to:

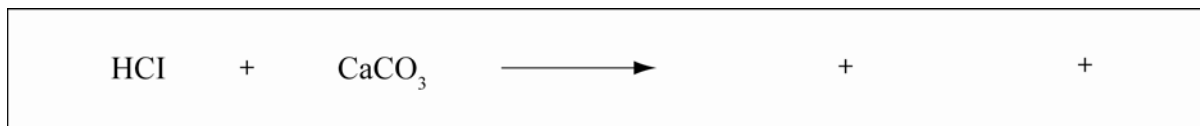
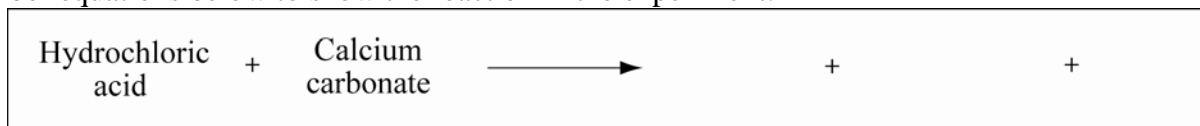
- particles
- collisions
- reaction rate.

3) Marble chips (calcium carbonate) are added to dilute hydrochloric acid in a conical flask. The flask is connected to an inverted measuring cylinder in a trough of water, as shown in the diagram below. The volume of gas produced is measured over a few minutes, and the results used to sketch a graph.



(a) The slope of the graph is steep at the beginning and then levels off over time. Explain what is happening, in terms of particles, during the reaction.

(b) Complete the word and symbol equations below to show the reaction in the experiment.



(c) The experiment is repeated but this time the same mass of marble chips is crushed into a powder before it is added to the flask.

Discuss the effect on the reaction rate of using powdered marble with hydrochloric acid compared with using marble chips. In your answer, you should:

- compare the rates of reaction
- explain the differences in the reaction rate by discussing how crushing the marble chips affects the number of particle collisions.